

# OPERATION EVEREST

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1946



SCHOOL OF AVIATION MEDICINE  
U. S. NAVAL AIR STATION  
PENSACOLA, FLORIDA  
1946



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THE PROGRESS OF "OPERATION EVEREST" HAS BEEN FOLLOWED WITH THE GREATEST INTEREST X THIS IMPORTANT STUDY AS CONDUCTED REFLECTS GREAT CREDIT UPON THE COMMAND AND TO THOSE DIRECTLY RESPONSIBLE FOR ITS CONCEPTION AND ITS SUCCESS X PARTICULAR CREDIT IS DUE THE VOLUNTEERS WHO AS SUBJECTS CONTRIBUTED SO MUCH.

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W. D. School of Aviation Medicine  
Philadelphia, Pa. 19104

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## FOREWORD

The purpose of this booklet is to present in simple, non-technical language the story of a group effort. It is the work of nearly fifty people working as a team on a peace time Navy job. We do not propose to discuss the scientific results of Operation Everest. Apart from the knowledge gained in medicine and aviation the months of work which this group gave to the project are a story in themselves. There were no crises. There was no great excitement. The thrills, drama and urgency which give stimulus to men in battle were entirely lacking. Yet these people, working with loyalty and cooperation, careful, painstaking and persistent, wrote a new chapter in science. We have told the history of the project and we have outlined the story of each individual, to show what a diverse group of men and women, from every background, from nearly every state, can do when welded together as a team.

The photographs which illustrate this booklet are selected from the many taken by students and instructors of the Naval School of Photography. These men included O. H. Gault, PhoM3c, Joe Usher, PhoM2c, W. W. Hathaway, S1c, and C. G. Thacker, S1c. Members of the developing and printing crew were: E. M. Waldo, PhoM1c, W. E. Nesbitt, S1c, D. E. Taylor, S2c and R. C. Findley, S1c.

Many people who assisted the project in one way or another are not mentioned by name, for the list would be too long. Personnel of the Commissary Department, for instance, provided the food which kept the subjects well and happy. Engineers and electricians from Public Works watched over the equipment. The staff of the Office of Public Information, particularly Lieut. John Self, USNR, were of constant help in many ways. Most of the text of this booklet is the work of David G. Stahl who started it while still in the service and continued after his discharge.

We particularly thank Miss Constance Peart for her help with the manuscript.







## THE PROBLEM

Five years of wartime-hastened progress has carried aviation far beyond its earlier boundaries, and pilots routinely fly at altitudes considered unattainable a few years ago. The struggle to reach higher altitudes has been successful only through the development of excellent oxygen supply systems, for the pilot, accustomed to sea level atmospheric conditions, becomes very inefficient above 15,000 feet, and will rapidly lose consciousness above 18,000 feet without supplementary oxygen. This inability of sea level man to tolerate high altitude and the accompanying lack of oxygen is in sharp contrast to the mountaineer who, after spending weeks of gradual ascent, can live and work at altitudes impossible to his fellows at sea level. The difference between the mountaineer and the pilot is acclimatization—the gradual adjustment of the body to the lack of oxygen. The specific changes in the body which make possible this adjustment have prompted many studies in the Rockies and the Andes, as well as in the laboratory. But these mountain expeditions all faced climatic and geographical problems which made their work very difficult and limited the scope, as well as the maximum altitude, of their studies. Even the splendid Peruvian expeditions could not work above 20,000 feet, and were able to make only a few observations at that altitude.

On the other hand, the low pressure chamber is ideally suited for the long-term study of the effects of altitude, as well as for the training programs for which it was originally designed. Not only can any altitude up to 50,000 feet be simulated exactly, but temperature and humidity can be controlled, the subjects can be provided with the best of food and comfort, and—most important of all—they can be studied and observed by physiologists who are not themselves affected by the altitude. After the wartime emergency demand for pilot training had slackened, the chambers and their crews became available for such studies.

Operation Everest was conceived by Lieut. Comdr. Charles S. Houston, a seasoned mountaineer who had climbed to 26,000 feet in the Himalayas and who had taken part in the Navy altitude training program for several years. He hoped to keep a small group of men continuously within a low pressure chamber, decreasing the pressure gradually to simulate an actual mountain ascent giving the subjects time to make the necessary physiological changes. With good subjects, careful planning, coordinated team work, and good luck, it should be possible for these men to acclimatize to altitudes which would cause unacclimatized men to faint in a few minutes.

From the beginning it was obvious that such a study must be a team effort, involving several closely knit groups of personnel as well as perfectly functioning equipment. The project was discussed with representatives of the Bureau of Medicine and Surgery in 1945, but was deferred owing to the uncertain conditions of that period. In March of 1946, the project was suggested to Captain Ashton Graybiel, Head of the Research Division of the School of Aviation Medicine. He became immediately enthusiastic and presented the plan to Captain Louis Iverson, Senior



Medical Officer of the Naval Air Station. A formal project request was submitted in March of 1946, and thanks to the combined efforts of Captain Iverson and Captain Graybiel, the project was approved by Vice Admiral Ross McIntire on 25 April, 1946.

Two months of intense activity followed. It was necessary to assemble a team of physiologists to carry out the numerous blood and respiratory analyses, and a team of cardiologists to study physical fitness and the effects of altitude on the heart. A thoroughly trained crew of low pressure technicians had to be assembled to maintain the twenty-four hour watch on the subjects during the month-long study. Auxiliary vacuum pumps and power supplies, a complete kitchen, and unnumbered other small but vital details were necessities.

The largest of the three low pressure chambers at the School of Aviation Medicine was selected for the project and stripped of all non-essential equipment. Into the space measuring ten by ten by seven feet were fitted four bunks, a table, chairs, two lockers, a toilet, washing facilities, duplicate communication and lighting systems, oxygen regulators for the inside observers, an oxygen analyzer, and other smaller pieces of apparatus. Three completely separate power supplies were provided by the Public Works Department of the Naval Air Training Bases under the guidance of Mr. William E. Cater, who himself undertook the overhaul of all the operating equipment.

Lieut. Comdr. Richard L. Rilev assembled an efficient laboratory team including Lieut. Walter Jarvis, Mr. Frank Consolazio and Mr. George Selden (loaned to the Navy through the generous cooperation of Dr. Dill of the Harvard Fatigue Laboratory). This group was to make the studies of arterial blood and alveolar, or lung air specimens, which show the greatest changes as men adjust to altitude.

Captain Graybiel and Lieut. John Patterson planned to study the physical fitness of the subjects from day to day and also to watch the effects of lack of oxygen on the heart through X-rays and electrocardiograms. Dr. John Remington of the University of Georgia Medical School joined the staff to aid in the study of circulatory physiology.

Providing hot appetizing meals for the men was one of the more important problems of the project, for the subjects would lose their appetites with increasing altitude, and the effects of various items of their diets upon their acclimatization needed careful analysis. For this purpose Lieut. Comdr. Margaret Halev of the Navy Nurse Corps was assigned to the project from the U. S. Naval Hospital at Key West.

The clinical laboratory of the Dispensary took over routine blood and urine analyses under the guidance of Chief Pharmacist's Mate Emanuel N. Buckley, and Hospital Apprentices Bunch and Axler of the X-ray department were to take the portable heart X-rays in the chamber. Wave Marvel Jones of Dr. Patterson's laboratory was assigned to the project as an assistant in cardiology.

Chief Pharmacist Frerichs, Property and Accounting Officer of the Naval Air Station Dispensary, was repeatedly called upon for assistance in procuring supplies, and through his patient and continuing support all the necessary equipment arrived in time.

The operating crew required fourteen men, and those were drawn from a class of low pressure chamber technicians then under training. These men would bear the brunt of the operating routine. Fortunately three men, Machinist's Mate Bentley, Fireman Bergeron and Pharmacist's Mate Vaughan, who had previously worked in this chamber for several months, were available and about them as a strong nucleus the operating and maintenance group was formed.





## THE PERSONNEL



**Captain Louis Iverson, (MC) USN, Senior Medical Officer**

Captain Louis Iverson, (MC) USN, Senior Medical Officer, graduated from the University of Illinois in 1917. He entered the Navy immediately after graduation and served on convoy and transport duty during World War I. In connection with the rescue of Canadian troops from a shipwrecked British troop-ship near the coast of Newfoundland, Captain Iverson was awarded the Navy Cross. A member of the first class of Navy Flight Surgeon, he received flight training at Pensacola in June, 1922, after graduating from the Army School For Flight Surgeons at Mitchell Field, New York, and is now the Number One Naval Flight Surgeon in length of service. He was assigned to the Naval Air Station at San Diego as its first Flight Surgeon, and later served tours of duty as Flight Surgeon on Staff Commander Battle Fleet, and Staff Com-



mander Cruisers Battle Fleet. Later he was Senior Medical Officer at the Naval Air Stations Seattle, Pearl Harbor, and Alameda. He was so serving at Pearl Harbor at the outbreak of the Second World War and was awarded the Purple Heart for wounds received in the attack of 7 December, 1941, when that medical department did such an exceptionally outstanding job for the wounded of the stricken ships. Now the only remaining member of the original group of Navy Flight Surgeons still on active duty in aviation, Captain Iverson is serving his fourth tour of duty at Pensacola.



**Captain F. Kirk Smith, (MC) USN, Executive Assistant to the Medical Officer**

Captain F. K. Smith, (MC) USN, executive assistant medical officer of the Dispensary, graduated from the College of Medicine at the University of Illinois and immediately after graduation in 1931, entered the Navy, being assigned to duty at the Naval Hospital at Great Lakes, Illinois, until 1933. In 1939, Dr. Smith was sent to the School of Aviation Medicine for instruction as a Flight Surgeon and was later assigned to duty at NAS Guantanamo Bay, Cuba, where he was stationed at the outbreak of the war. During the war he was Medical Officer aboard the USS Long Island when she participated in supporting landings on Guadalcanal. In November, 1943, Dr. Smith was assigned to the famed USS Franklin and served as Senior Medical Officer until May, 1945, when he reported to the Naval Air Station at Pensacola. For his heroism aboard the Franklin, Captain Smith received the Navy Cross.







**Captain Ashton Graybiel, (MC) USN, Coordinator of Research at the  
School of Aviation Medicine**

Captain Ashton Graybiel, (MC) USN, now Coordinator of Research at the School of Aviation Medicine, Naval Air Station, Pensacola, is a graduate of the University of Southern California and Harvard Medical School. After his internship he spent one year on the Mosely Travelling Fellowship in Sir Thomas Lewis' Laboratory at University College, London. In 1935, he became an instructor in medicine in the graduate courses at Harvard Medical School and later was associated with the Harvard Fatigue



Laboratory. Captain Graybiel is particularly interested in cardiovascular problems, and is co-author of a book on electrocardiography. Shortly after entering the Navy in 1942, Captain Graybiel became an instructor in the School of Aviation Medicine at Pensacola, where he has worked on the general problem of disorientation in pilots. Under Dr. Graybiel's direction in his capacity as Coordinator of Research for the School of Aviation Medicine "Operation Everest" was planned and carried out.



**Lieutenant Commander Charles S. Houston, (MC) USNR,  
Officer-in-Charge of Operation Everest.**

Lieutenant Commander Charles S. Houston, (MC) USNR, of Great Neck, New York, was the officer-in-charge of Operation Everest. During his undergraduate work at Harvard, and also during his medical training at Columbia Medical School, he participated in summer mountain climbing expeditions in Alaska and India, and following his internship at the Presbyterian Hospital in New York, he entered the Navy in 1941. After completing the course in Aviation Medicine, he was assigned duty at Naval Air Stations at Norfolk, Jacksonville, and Miami in charge of altitude training units. In 1942, Dr. Houston initiated the practice of having



students remove their oxygen masks at 30,000 feet during their altitude training runs, to impress them with the sensations and dangers of lack of oxygen. This practice soon became routine procedure throughout the Navy altitude training program. As a mountaineer, Dr. Houston has climbed to 26,000 feet in the Himalayas, and was a member of the British-American expedition which in 1936, climbed 25,600 foot Nanda Devi, the highest summit yet reached. With this background of high altitude experience, he had long wished to study the process of acclimatization, and drew up plans for Operation Everest in 1945, presenting them for approval in early 1946. Dr. Houston directed the preparations for the study and was in charge of operations, living in the chamber building for the entire month where he would be instantly available in case of emergency. After his discharge from the Navy, he plans to enter private practice in Exeter, New Hampshire.



Lieutenant (jg) Walter McNutt, H(S) USNR, came from NAS Miami to be a subject in Operation Everest. Horace C. Hertel, PhM2c, USN, spent most of his time extolling the beauties of Oregon. Carlton R. Morris, HA1c, USN, eats some raisins which were given the men to increase their iron intake. Earl D. Wilkins, Jr., HA1c, putting in his daily exercise period with all the comforts of home.





## THE SUBJECTS

When Operation Everest was officially sanctioned and early plans were formulated, interest ran high and a number of men volunteered to be the subjects. Since there was only room in the cramped quarters for four men, it was important that those selected be physically and psychologically able to last out the full term of the project. They had to appreciate the difficulties ahead of them and be determined to do their utmost to make the project a success. After numerous interviews, examinations and tests, four men and one stand-by were selected.

Lieut. (jg) Walter Scott McNutt, H(S) USNR, of Jefferson, Texas, was stationed at the Naval Air Station, Miami, when he first heard of the proposed study and immediately volunteered as a subject. He had attended Arkansas College at Batesville, and Henderson State Teachers' College at Arkadelphia, where he received his A.B. degree in Chemistry. After graduation he did research work at Brown University for which he received his M.S. degree in Biology in 1943. He then entered the Navy and was assigned to Naval Air Stations at Pensacola, Corpus Christi, and Miami, working in altitude training at each station. After his discharge from the Navy, McNutt returned to graduate work in biological chemistry.

Carey C. Kerby, Jr., Hospital Apprentice, first class, USN, of Jacksonville, Florida, had only been working in the Dispensary at the Naval Air Station for a short time when he heard of the plans for Operation Everest and promptly volunteered as a subject. A student at Robert E. Lee High School in Jacksonville, when he entered the Navy in September, 1945, Kerby had recruit training at San Diego, California, and after attending Hospital Corps School in San Diego, he was stationed at the Corona (Calif.) Naval Hospital for two months. He was transferred to Pensacola in May, 1946, and assigned to duty in the Eye Department at the Dispensary.

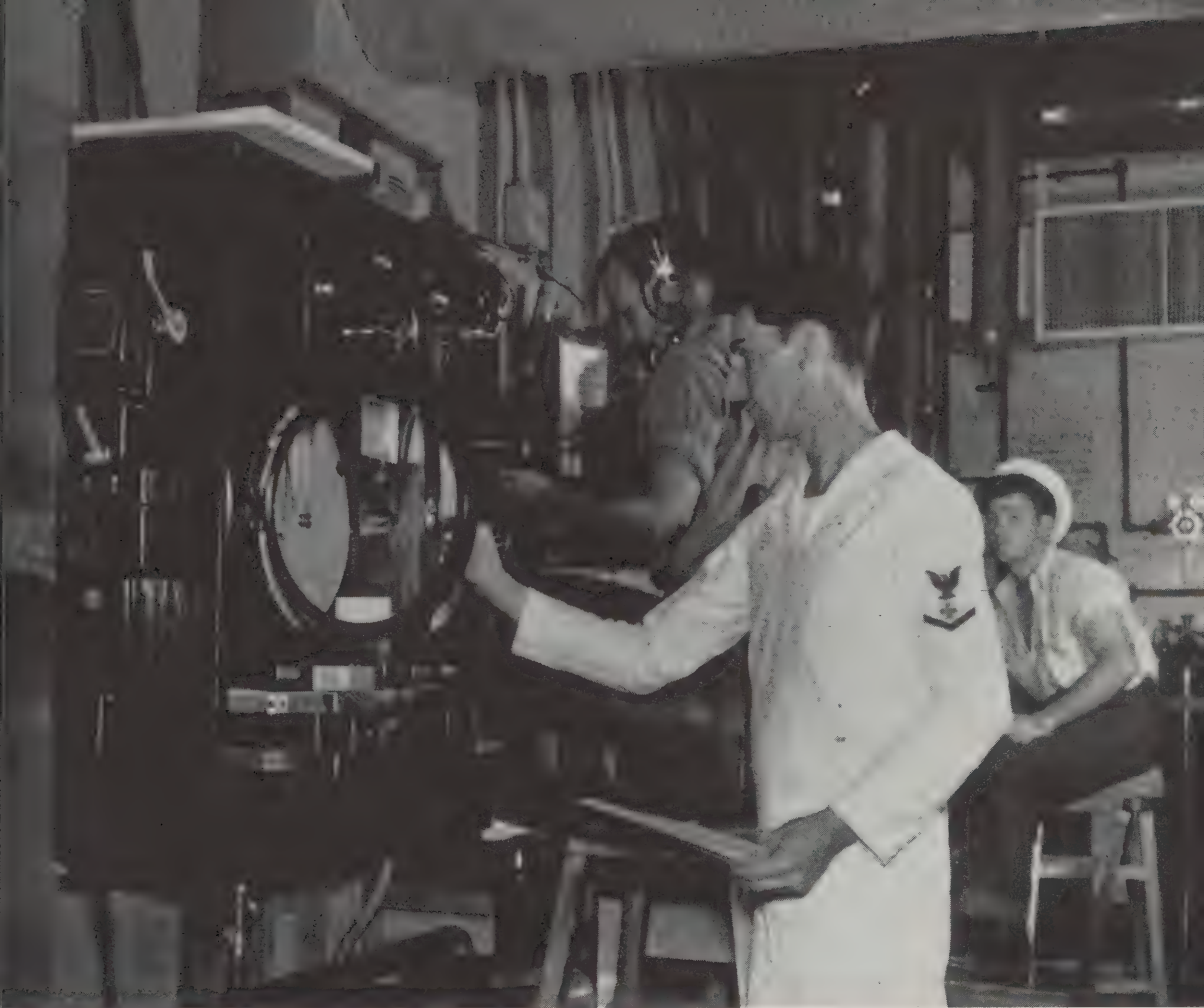
Horace Carl Hertel, Pharmacist's Mate, second class, USN, of The Dalles, Oregon, joined the Navy immediately after graduation from The Dalles High School in 1942. Following recruit training and Hospital Corps School at San Diego, California, he served at Bremerton, Wash., and Farragut, Idaho, until he was sent overseas to Base Hospital No. 2 in the New Hebrides. Hertel's next duty was aboard the USS Maryland. He saw action in the Gilberts, Marshalls, at Kwajalein, the Marianas, Saipan, Pelelieu, and Leyte, finally leaving the ship in February, 1945. After a short assignment at Pearl Harbor, Hertel returned to the United States and was assigned to the Dispensary at the Naval Air Station, Pensacola.

Earl D. Wilkins, Jr., Hospital Apprentice, first class, of Dorchester, Massachusetts, was the New England representative among the four subjects. A graduate of Roxbury Memorial High School, Wilkins entered the Navy in September, 1943, and took recruit training at Newport, Rhode Island. After Hospital Corps training at Portsmouth, Virginia, he was assigned to the Naval Air Bases at Corpus Christi and Kingsville, Texas, until October, 1945, when he was transferred to Pensacola for duty as an



aviation medical technician assigned to flight physical examinations. Wilkins plans to make the Navy his career.

Carlton Royce Morris, Hospital Apprentice, first class, of Farmerville, Louisiana, was chosen to replace Kerby before the ascent began. A graduate of Farmerville High School with the class of 1944, Morris enlisted in the Navy in February, 1945, and underwent recruit training and Hospital Corps training at San Diego, California. In September, 1945, he was transferred to duty at the Naval Hospital, Pensacola, where he worked on the wards until May, 1946, when he was transferred to the Naval Air Station Dispensary. Morris heard about Operation Everest within two days of reporting for duty and requested assignment to the project as one of the four volunteers. When he was not selected, he stood by on the possibility that one of the volunteers previously chosen might have to be replaced, and thus became one of the four men to finish Operation Everest.



Men were on watch twenty-four hours a day outside the chamber while Operation Everest was in progress. Here Vaughn changes recording papers, Freeman speaks to the men in the chamber, while Morgan stands his watch at the controls.

## THE LOG

JUNE 27

Everything is ready at last. The crew finished cleaning up the chamber this afternoon, and the place is neater than it will be for the next month. It scarcely seems possible that just a week ago we thought we would never be ready in time. The auxiliary vacuum pump and diesel generators had been installed but there were so many other tiny details that we had little hope they would be finished by tonight. They are, and we're ready.

JUNE 28

It rained during the night for the first time in nearly a month, and in the midst of a downpour the first watch reported for duty at 0700 this morning. Despite all the confusion, things somehow seemed to get done. The main suction valve was removed and greased for the last time, in the



nope that it would give no difficulty in the coming weeks. At 0829, the pumps were started and our four subjects entered the chamber. The door was closed as Riley, Jarvis, Houston, Hoffman, and Selden also entered the lock for the first trip; Operation Everest was underway.

The morning passed quickly as the first blood tests were carried out on McNutt, and the boys had worked up good appetites by the time the noon meal came up in the lock. In the middle of the afternoon, we compromised with our "breathless public" and let the boys out of the chamber for innumerable photographs. We took this opportunity to let Dr. Patterson run his first sea-level tests in the lock. At 1700, we finally sealed the door to end the first day's work and to give our subjects a minute to themselves. They drew lots for bunks, stowed their gear, and finally settled down to a steak dinner. The first night watch reported at 2300, with the rain still pouring down. Our first, and in many respects our most difficult day was finished.

### **JUNE 29**

Still at sealevel on Saturday morning, and with the rain still pouring down outside the chamber, the second day began. The rain makes things difficult for Miss Haley and her crew, who have to carry trays from the other building, besides giving us a difficult problem in dehumidification, for we have "rain" inside the chamber. All the tests are taking longer than originally scheduled, and we're quite pleased to have these three days at sea level to iron out the problems of routine without having to worry about maintaining reduced pressure in the chamber.

Cardiology tests occupied the whole afternoon, and in the evening we started a special Saturday night practice; all four of our subjects had baths! It took two hours to finish and wore out the crew, since the GI can "bath tub" must weigh nearly 400 pounds when full.

### **JUNE 30**

Still raining hard. Dr. Riley's crew started the day's activity with a good blood study on Wilkins, but a second attempt to study Kerby failed. His arteries are either too small or too variable to take the arterial needle. This was our first setback and we were forced to make a change in plans. Fortunately, Morris had been standing by for the past two weeks, hoping for just such an eventuality and he replaced Kerby this afternoon. Most of the preliminary tests had already been run on Morris, and we had to complete only a few before he joined the three men still in the chamber. Kerby was bitterly disappointed, and very reluctant to leave. We hated to make the change, since he has been so cooperative.

The boys listened to radio broadcasts from "Operation Crossroads" this afternoon and said the reception was excellent.

Many people have asked why we have kept the chamber at sea level for three days with the doors closed and the subjects inside. There are two good reasons. First, the men in the chamber and the operating crew have had a chance to get used to the routine without the difficulty of altitude. Secondly, we can collect control data to compare with the data collected later at altitude.

Finally, at 2000, the chamber started its ascent with an initial 2,000 foot hop—at least this is what was supposed to happen. Actually, Allen

and the half-dozen onlookers were so engrossed in the take-off that they watched the needle on the altimeter climb to nine thousand feet before they realized that they were misreading the dial. There were a good many red faces when the chamber finally leveled off at 2,000 feet for the night.

### **JULY 1**

Today has been rather uneventful; there was no blood work in the morning, and Dr. Patterson and Dr. Graybiel took over for the afternoon. Our first emergency drill was carried out with considerable confusion this morning, but we did get the diesels turning over and restored power to the pump in three minutes. The routine is beginning to shake down. We made only sixteen lock trips today, compared to 28 yesterday and 33 the day before. The chamber climbed to 4,000 feet at 1800.

### **JULY 2**

Our second emergency drill this morning was better than that of yesterday. Again there were no blood tests, as Dr. Riley's group is improving its techniques. Our first visitors were entertained today. A delegation of Swiss Naval and Army officers visited the School of Aviation Medicine and inspected the project. Captain Kline, Admiral Wagner's Public Information Officer, today got three men to help Miss Haley in the galley. Originally, we had planned to rotate the messing detail among the crew, but this has not worked out well and Miss Haley has been doing far more than she should. The three mess boys have stepped into the routine very well. Tonight we went up to 6,000 feet.

### **JULY 3**

We spent another quiet day today. There were no blood studies in the morning. Cardiology took over in the afternoon; the routine was further adjusted for the difficult days ahead. The chamber climbed to 8,000 feet tonight.

### **JULY 4**

Independence Day—but no freedom for our four subjects, or for the crew. The first noticeable symptoms of oxygen lack appeared when the subjects suffered slight shortness of breath during exertion. The humidity in the chamber reached an all-time high of 90% and was so disagreeable that we reluctantly interrupted Mr. Cater's holiday, and he spent six hours this afternoon installing an auxiliary drying apparatus which may solve our problem. In the evening the boys celebrated the holiday with a movie and beer which were furnished by the Red Cross. We decided to retard the ascent to 1,000 feet daily to give more time for acclimatization, so we only reached 9,000 feet tonight.





Arterial blood studies were made daily by Dr. Riley, shown withdrawing the blood, while Dr. Houston checks time and respiratory rate.

### **JULY 5**

We start our second week. Dr. Riley's group did a good blood study on McNutt during the morning and the past five days spent in improving techniques paid dividends. It's still "raining" inside the chamber. Humidity control is going to be one of the major, and unexpected, problems. Even 9,000 feet is noticeable to the crew members, who are making several trips a day without oxygen. The chamber climbed to 10,000 feet just before the movies.

### **JULY 6**

Our first day on oxygen for the crew, making the lock trips much more complicated. Judicious use of the refrigeration and drying equipment is bringing humidity and temperature under control. Another climb to-night, and we are now at 11,000 feet.

### **JULY 7**

Sunday again, but no day of rest. It has been another smooth and uneventful day, with good blood studies in the morning and Dr. Patterson's tests in the afternoon. Inside the chamber arguments wax hot over the

relative size of Oregon fish, trees, and mountains, compared to those of any other part of the country. Hertel has a tough time, particularly since he's up against a Texan. McNutt is busily whittling away at a mahogany block, and the shavings already fill two waste baskets. Hertel's first model plane is finished and he has started on a second. We reached 12,000 feet tonight.



Though the chamber was crowded, each of the men was soon busy; McNutt with his woodcarving, Hertel building model airplanes, while Wilkins and Morris play cards.

### JULY 8

Subjects and crew seem to be in the groove now. The daily routine starts with reveille at 0615, when blood pressures, pulse rates, alveolar air samples, and weights are taken. Breakfast is at 0715, and the blood studies begin at 0800. After they are completed, usually at 1000, the boys spend an hour or so on the bicycle before lunch at 1130. After their noon rest period, electrocardiograms and physical fitness tests occupy the afternoon, ending at 1600, in theory if not in fact. Sometimes we have time for one bath before supper; if not, both must be given before the movies, which are scheduled for alternate nights. By 2200, our subjects are more than ready for bed. For those outside the chamber, the work goes on around the clock. Two men are on duty at the porthole and the controls every minute of the day and night. It's hard for an outsider to realize the amount

of detail which keeps more than twenty men busy practically all the time. Our altitude tonight is 13,000 feet, and all four subjects notice blue fingernails and shortness of breath on exertion.

### **JULY 9**

This started out to be a bad day. We are now in the intermediary period—high enough to give symptoms in the subjects and trouble to the observers, but not so high as to be exciting to us or to anyone else. The four day holiday caused an acute shortage of linen which has been carried over until we are now in the fifth day without clean sheets and towels for our men—not too important until one realizes that they spend most of their day in or on their beds. Then the old problem of humidity came up again—not yet under control. The crew could not get coffee—and whoever heard of a Navy man without his coffee mess? The subjects definitely notice this altitude—they easily become short of breath, their nails are blue, especially on exertion, and their sleep is more fitful and broken. Two of them already show the irregular Cheyne-Stokes type of breathing, which at sea level is a frightening sign, but is the customary type at altitude. At 1800 we climbed to 14,000 feet.

### **JULY 10**

Today was a good deal better, but the first signs of irritability appeared in our subjects, and they require more pampering. Usher went up in the lock and took an excellent series of pictures of the blood tests. Miss Vise of the Red Cross arrived today with leathercraft and weaving equipment which were enthusiastically received by Morris and Wilkins. The chamber is at 15,000 feet this evening.

### **JULY 11**

This has been a full day. Commodore Adams, Chief Naval Flight Surgeon; Captain Korb, Head of Aviation Medical Research; Surgeon Captain Graff of the Royal Air Force; Captain Holland, and other representatives from the Bureau of Medicine and Surgery spent most of the day observing operations. In the evening some of the party went up in the lock for a visit with the boys and had trouble getting back to sea level because of ear troubles brought on by the change in pressure during descent. We again slowed the rate of ascent, and went up just 500 feet over a two-hour period.

### **JULY 12**

Commodore Adams gave a very encouraging short talk to our subjects, and boosted their morale enormously. He emphasized the pioneering aspects of the study, as well as its great theoretical and practical significance, and urged the boys to give their best efforts, inasmuch as they are writing medical history. The chamber is at 16,000 feet tonight and the boys feel much better with the slower rate of ascent.





After the day's work was done the subjects really enjoyed a hot bath in this improvised bath tub.

### JULY 13

Today the laboratory tests again indicated that there is some hemoglobin in blood of the four subjects which is not carrying oxygen; this requires much more study. Inside the chamber things are going smoothly. McNutt has completed his wood carving of the head of an old seafarer; Hertel is in the midst of building his second model plane; Wilkins' model "crashed" after the fuselage was complete; Morris is busily weaving a rug. The log contains an entry at 1530 this date: "Kilroy was here." Four baths tonight, a special concession to Saturday. The chamber is now at 16,500.

### JULY 14

Nothing particular today. The chamber reached 17,000 feet at 1620.

## **JULY 15**

The Navy's discharge of reserve enlisted personnel took one of our men today; Bentley, our driver, left for separation. We spent two hours for the climb to 17,500 tonight. The four boys definitely feel this altitude, and the blood tests give the first indication that their acclimatization is not proceeding as rapidly as we had hoped.

## **JULY 16**

Only McNutt is maintaining his 25-mile a day bicycle ride, while the others have to be urged to ride even five or ten miles. All the data seems to confirm our finding of the unusual type of pigment in the blood, and we are becoming more excited by this. This evening brought our first emergency: at 2100 all power suddenly and unexpectedly failed, and our repeated emergency drills proved their value. It took three minutes to restore power to the pump from the generator, but another half hour before the trouble was finally traced to a sticking relay. Mr. Cater again gave invaluable assistance. One amusing sidelight was the spectacle of the subjects peering out the portholes quite unconcernedly while the operating crew ran frantically about with flashlights. Incidentally, we have begun to notice occasional cases of mild "bends" in members of the operating crew who have been making from one to five trips in the lock during the course of the day. This is unusual at such low altitudes and may prove to be a major difficulty. We climbed to 18,000 feet this evening, and will spend the next two days at this altitude.

## **JULY 17**

There were several tense moments this morning, while Mr. Cater tried to determine the cause of our power failure last night. For a time it seemed that we would lose one transformer, but finally after several fuses were blown the trouble was located and corrected.

## **JULY 18**

Our second day at 18,000 feet. The boys definitely notice an improvement over the first day at this altitude. All the tests are going smoothly, and the data already collected has more than justified the project. The chamber moved up to 18,500 feet tonight.

## **JULY 19**

Dr. John Fulton, Professor of Physiology at Yale University, arrived today and was very enthusiastic about the project. In the afternoon Admiral Wagner and his staff attended the first showing of the movies which have been taken thus far. One severe case of cerebral bends occurred today, causing temporary blindness in one of the operating crew. The tension among the crew is increasing quite noticeably as the altitude increases. Our subjects have stopped work on their several hobbies, and McNutt is the only one who takes his daily exercise. We moved the chamber up to 19,000 feet today. During the night two fuses blew, but they were replaced quickly.



**"You men are real heroes," said Rear Admiral Frank Wagner, as he, Captain Iverson, Dr. John Fulton, and Captain Sinton speak some words of encouragement to the four volunteers.**

### **JULY 20**

Rear Admiral Wagner came to the unit this morning and spoke to the boys in the chamber. Captain Iverson and Dr. Fulton also spoke, and the entire program was recorded on wire. Admiral Wagner said in part, "This is the first opportunity I ever have had to talk to heroes at the instant they are being heroic . . . You men . . . have gone into this thing with your eyes wide open, courage screwed up to the top limits, and your persistence and endeavor at the highest level . . . you are true pioneers in the physiology of high altitudes . . . On behalf of the Navy, I thank you for what you are doing here." Dr. Fulton, in commenting on the value of our project said, "I regard Operation Everest as having not only great theoretical significance, but also very real practical importance, for this is the first time normal observers, with all needed equipment readily at hand, have been able to make an objective study of men undergoing acclimatization to altitude. The results already obtained appear to be highly significant, and they will be studied with eager interest by physiologists and flight surgeons throughout the world . . . The Secretary of the Navy and Admiral Wagner, as well as all of the personnel of this Air Station, can point with justifiable pride to this epic experiment." Needless to say, all these words of praise boosted everyone's morale, and left the crew in danger of needing a collectively larger hat size.



Our four subjects are in much better condition than they were yesterday, but it is amazing how much they vary from day to day. They now seem to be better than at any time since leaving 12,000 feet. There are only two flies in the ointment: they are not sleeping well, and have lost their appetites. All have lost a little weight. Tonight there seems to be no doubt that we will go much higher.

#### JULY 21

Our second day at 19,000 feet. When the results of the morning blood studies were calculated, we found that the inactive type of pigment was higher than ever. There seems to be no doubt that this is a real and significant finding, and one that justifies thorough investigation. After considerable red tape had been slashed, Dr. Graybiel telephoned Dr. Horecker at the National Institute of Health in Washington, to request a spectrophotometric analysis of this blood. If we can arrange this, blood will be flown up tomorrow or Tuesday. The chamber climbed to 19,500 feet early in the evening. Our four men do not sleep at all well up here, and their restlessness is directly correlated with their irregular gasping type of breathing. A second observer had temporary partial blindness from cerebral bends.



Blood counts were made by Chief Buckley at regular intervals to follow the increase in red cells which is one of the changes in acclimatization. Wilkins here seems more amused than is Morris.

## **JULY 22**

Most of this day was spent in discussions of plans. The developments surrounding the inactive pigment have been so striking and so swift, that several possibilities are open to us: investigate this pigment as it now exists in our boys, or feed them large doses of vitamin C (which may make the pigment active). We finally made contact with Dr. Horecker at the National Institute of Health and all plans are now completed to fly a specimen of blood to Washington tomorrow morning. In the evening we had a fleeting visit from a group of prominent citizens of New Orleans who are visiting the Training Bases. We remained at 20,000 feet again tonight. At this altitude it takes a minimum of twenty minutes for a round trip in the lock, and we are now spending approximately five hours out of each day just going up and down.

## **JULY 23**

Much as usual, it was pouring rain this morning, and the plane carrying Morris' blood to Washington was delayed until ten o'clock. All four of our subjects are definitely improved by the stay at 20,000 feet. The operating crew is showing more signs of strain, and "bends" are becoming much more frequent. It's getting still harder to get the subjects to do much exercising. We climbed to 20,500 feet this evening.

## **JULY 24**

It is becoming increasingly more difficult to rely on the subjects to collect specimens themselves. Morris forgot once to collect a specimen of urine, thus ruining the vitamin tolerance tests being run on him, and Hertel spilled his entire sample. A long distance telephone call from Washington informed us this morning that the mysterious pigment in the blood samples flown to Washington could not be identified, and suggested that two specialists fly down from Washington to perform tests on the blood as soon as it is drawn. The whole problem becomes more and more exciting. We took the chamber to 21,000 feet tonight.

## **JULY 25**

Dr. D. B. Dill of the Harvard Fatigue Laboratory and Dr. Leslie F. Nims of the Aero-Medical Unit, Yale University, arrived today, and have been advising and encouraging us. Both are very reassuring as to the safety of our men, and we feel much more secure now that we have the benefit of their presence. The chamber reached 21,500 feet tonight, and, as has been the case for the past week, this ascent was made over a two-hour period.



**Captain Iverson reads an entry in the log to Dr. D. B. Dill, of Harvard University, one of our prominent visitors, while Hall keeps watch over the chamber.**

## **JULY 26**

Our four boys spent a very restless night and are even more sluggish than usual this morning. About eleven o'clock while photographers were taking moving pictures of Dr. Dill and Captain Iverson, the Klieg lights blew several fuses, and for some reason the emergency lighting also failed, leaving the lock in total darkness at a critical moment. X-ray men Bunch and Axler had just entered the lock prior to returning to sea level, and Axler had not had time to plug his oxygen mask into the lock supply. He lost consciousness, and fell against Bunch, who had the presence of mind to signal for a "crash dive." During the rapid descent, Bunch developed an ear block. With Axler still unconscious, Bunch decided to continue the descent rather than "level off" to relieve his ear, and on reaching sea level



had to have his ears treated. Axler recovered within a few minutes, but the whole incident forcefully pointed out to us the potential dangers of this altitude to the crew. At noon Captain Iverson and Dr. Dill went up in the chamber to talk with the subjects and spent a half hour before returning to sea level. During the day it was decided to have student flight surgeons stand night watches at the chamber, and tonight the first group took over the head observer's post in two-hour shifts while the operating crew stood two-hour watches inside the chamber throughout the night. This makes a very complicated night, since the lock trips must be made without disturbing the subjects, but everyone feels more secure.

### **JULY 27**

Drs. Bowen and Spicer from the National Institute of Health arrived early this morning to study the inactive blood pigment. The day was uneventful for the operating crew, but the subjects were even more sluggish and lethargic. They have not noticed headaches such as were prominent at lower altitudes, but they are not eating well, sleep poorly, and take little interest in the events of the day. After a long "council of war," we decided that it would be wise to lower the chamber to 20,000 feet for the night. This altitude is high enough so that the process of acclimatization will not be affected but low enough to give the boys a good sleep. Rear Admiral Wagner dropped in unexpectedly at noon, and spoke a few cheering words to the subjects and crew. To a casual observer outside the chamber, our subjects seem to be in very poor condition, since their color is bad and their breathing labored and irregular, but upon entering the chamber one cannot help but be impressed by their good spirits and essentially healthy condition. During the evening we made the retreat to 20,000 feet, but did not tell the subjects of this, for fear of dampening their morale.

### **JULY 28**

A dramatic change is apparent. All four boys slept wonderfully well and are pleased with their improvement, which they attribute to acclimatization. We thought it best not to disillusion them by telling them of their descent, so they are still in the dark about the reason for their improvement. The day passed uneventfully, and the flight surgeons again stood watch through the night, although this hardly seemed necessary since we stayed at 20,000 feet.



**The meals provided by Miss Haley were varied and as appetizing as possible, and the four men seem to be thoroughly enjoying this one.**

### **JULY 29**

Again our subjects feel much improved, since they spent another restful night. After the morning blood study, we decided to resume the ascent by climbing at 400 feet per hour to 22,500 feet. The boys did not notice the gradual increase in altitude, but all were sluggish when the chamber leveled off at 22,500, and they then realized that they had ascended again. In the afternoon we decided to demonstrate the difference between acclimatized and unacclimatized man at this altitude, using Kerby as the subject. Two movie cameras were set up in the chamber and focused on Kerby as he rode the bicycle. His oxygen mask was removed, and he continued riding, commenting meanwhile on his symptoms as he began to notice the lack of oxygen. The effects became progressively more apparent, and after five minutes and fifty seconds, he lost consciousness, falling from the bicycle as his oxygen mask was replaced. Hertel and McNutt then mounted the bicycle in turn and demonstrated how easily they could do the same amount of work. As the evening wore on it was quite evident that the four boys would not sleep well at this altitude, and once again we lowered the chamber, this time to 21,000 feet, for the night. To our great delight, Dr. Nims has become fascinated with the experiment and will stay with us until it is completed.



This is the day.

Things have moved rapidly during the past twenty-four hours. First, Dr. Riley is having increasing difficulty in placing the needle in our subjects' arteries, as the arteries are showing the effects of repeated punctures. At the same time, their blood is so thick it clots rapidly in the needle. Too, their appetites are very poor, and all have lost considerable weight and are feeling much weakened. It is apparent to all of us that their time in the chamber is drawing to a close, and since all the basic physiological data has been collected, we have decided to make what Dr. Nims and Dr. Graybiel term "a dash for the top." Plans were rapidly but carefully laid early today, and at 1041 the chamber began its ascent at the rate of 1,000 feet per hour. At noon, Dr. Houston joined the boys for lunch at 22,000 feet, taking with him various pieces of apparatus for making tests and recording observations. The slow ascent continued all through the afternoon. Once an hour each man rode the bicycle for five minutes, meanwhile making comments on his sensations. Pulse rates were counted, heart action recorded on the electrocardiograph, and careful observations spoken on the wire recorder. The atmosphere within and without the chamber was tense. Outside Dr. Nims sat at the observer's post through the long afternoon. Each thousand feet was more difficult than the preceeding one. The chamber had reached 25,500 feet by 1513, when Rear Admiral Wagner and Major General Donald Wilson arrived to watch. By the time the chamber reached 26,500 feet at 1611, Wilkins was approaching his peak altitude, and a few minutes later, at 26,700, he requested and was given oxygen. We were all on edge at this crucial point, for we had no idea how Wilkins would react when given oxygen. For weeks, these men had been starved for oxygen. One of their methods of compensating for oxygen lack has been to eliminate carbon dioxide, which acts at sea level as the chief stimulus for breathing. The question, then, is what will happen when a man is given pure oxygen in adequate quantities without also being given carbon dioxide? Will he stop breathing, since he no longer needs to compensate for lack of oxygen? Will he be intoxicated by the excess of oxygen? Will he notice no change? Wilkins took a few deep breaths of oxygen; his color changed from the deep purple of oxygen lack to a rosy hue. His breathing was normal. He commented on a sensation of pressure in his head, and then announced that he felt wonderful. There was no question but that he was greatly benefitted by the oxygen, nor was there any longer any fear of difficulty in the emergency use of oxygen.

The ascent continued. Hertel was the next to reach his ceiling. For several thousand feet he had become more short of breath than before, and found it difficult to ride the bicycle. At 27,500 feet, while walking across the chamber, he felt dizzy and nauseated. He returned to his bunk, leaned against the side, and asked for oxygen. As his mask was placed in position, he momentarily lost consciousness, but within a few seconds, like Wilkins, he took his oxygen without difficulty and returned to normal. McNutt and Morris staggered on. As each thousand feet was passed, Morris added a paragraph to the letter he was writing to his family. McNutt found that steam inhalations greatly eased his breathing. Both were able to ride the bicycle, but not comfortably. By 1738, we had reached 28,000 feet where both men were mentally alert, though not capable of strenuous exercise. The ascent was speeded up, and at 1751 the needle



on the altimeter crept up to pass the 29,000-foot mark and reach a maximum of 29,025. Our men were now 23 feet higher than the summit of Mt. Everest, and they remained at this altitude for twenty-one minutes. Both described their sensations clearly, and expressed pride in their accomplishment. The final samples were collected, and the chamber started down to 20,000 feet for the night. Our four subjects turned in early, well satisfied with their day's work.

## JULY 31

Last night passed uneventfully with all four boys sleeping well. Today the last major tests are scheduled. We will take two of our four subjects to the highest altitude they can reach, using only standard oxygen equipment.

During the morning the usual blood work and cardiology was performed, and last-minute preparations were made for the high climb. At 1440, all four men were fitted with helmets and standard oxygen masks. When all preparations were complete, the lock and chamber were climbed to 35,000 feet. McNutt and Morris were chosen to make the first attempt, and the other two retired to the lock with Dr. Houston. Communications were given a final check, the lock door was secured, and the chamber was taken up to 45,000 feet. For the next hour it would be impossible for an unacclimatized man to remain conscious at the altitude where the two men would be. The chamber inched upward. At 48,600 feet Morris complained of abdominal gas pains, and the chamber was briefly lowered to 45,000 feet. Once again, the ascent was attempted, and once again, Morris' pain was too severe. Lock and chamber were again levelled, this time at 40,000 feet, and Wilkins replaced Morris in the chamber with McNutt. With the door secured, chamber and lock were again separated, and the slow ascent was resumed. Both men felt well up to 46,000 feet, the highest that men have gone without pressure suits. They climbed on upward, and at 1601 touched 50,225 feet. There was no cheering; instead, everyone inside and outside the chamber took the first deep breath of the entire afternoon. Both Wilkins and McNutt were mentally alert at this peak altitude, but both complained of weakness and dizziness, and after two and a half minutes, they descended to 46,000 feet.

The next objective was to determine the maximum altitude at which they could work efficiently, and during the next half hour the chamber slowly moved up to 48,500 feet. Each 500-foot step brought an increase in symptoms of oxygen lack. At 46,000 feet both men felt they could do light work indefinitely. When they reached 47,000 feet, they believed their time reserve would be several hours, and at 48,500 feet they felt that their efficiency would not last for more than thirty minutes. Our second objective accomplished, the chamber started down at 1648. The two men had remained at or above 45,000 feet for over one hour. During the descent all four removed their masks at 25,000 feet. To them, 20,000 feet seemed like home.

All four ate well this evening and celebrated with several bottles of beer.



On August 1 as the men reached sea level, Captain Iverson handed them their leave papers, while Rear Admiral Wagner and Dr. Houston look on.

### AUGUST 1

Our last day. Dr. Patterson and Dr. Graybiel plan to study the physical fitness of our subjects at 20,000 feet both with and without oxygen. We also plan to take X-rays and electrocardiograms at 24,000 feet.

The studies progressed satisfactorily, and by 1500 the altitude work was done, and the lock made its four hundred and ninth (yes, 409th) ascent of the month to bring down the cardiology and X-ray group. This last lock trip was honored with a special entry in the log, and there is scarcely any one of the crew who regrets that it is the last.

During the afternoon Dr. Ali Tewfik Shousha Pasha, the Egyptian Minister of Health and representatives of the Bureau of Medicine and Surgery discussed the project with Captain Iverson while waiting for the men to leave the chamber.

The building was stripped of furniture and overrun with photographers long before 1700 when the chamber door was opened and the men stepped out to be greeted with a barrage of flashbulbs, handshakes and congratulations from their distinguished visitors. All were thinner than they had been thirty-four days and eight hours ago when they entered the chamber, and all had grown beards. All felt in excellent health and spirits, and they, as well as all the operating crew look back with pride on the past month, as the final entry was made in the log: "Pumps secured, lights and communication secured—Chamber secured."

(The following is a sample twenty-four hours chosen at random from the log kept by members of the operating crew during the entire month of the project.)

### July 19

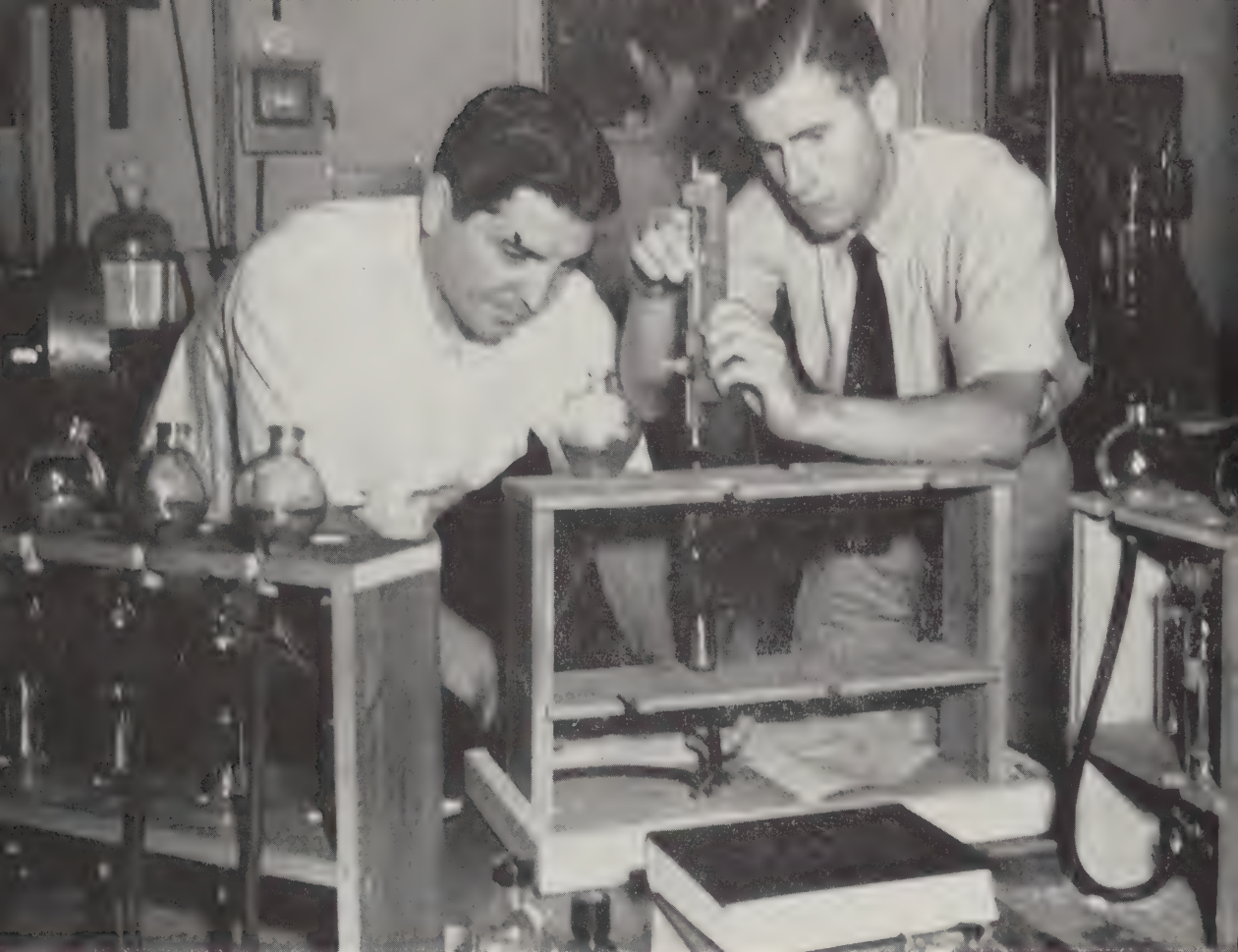
0600 Bishop and LePenske assumed watch.  
0620 Dr. Houston and Vaughan up in lock for morning studies.  
0630 McNutt Pulse—88 Blood Pressure—134/74 Weight—147  
Morris Pulse—68 Blood Pressure—130/80 Weight—150  
Hertel Pulse—60 Blood Pressure—112/78 Weight—146  
Wilkins Pulse—66 Blood Pressure—130/70 Weight—149  
0655 Dr. Houston and Vaughan down in lock.  
0700 Elms up in lock with chow.  
0735 Elms down in lock with dirty trays.  
0815 Houston, Riley and Selden up in lock for morning studies.  
0845 Selden down in lock with first blood.  
0855 Selden up in lock.  
0907 McNutt started exercise.  
0915 McNutt finished exercise.  
0916 Selden and Riley down in lock with blood.  
0930 Buckley up in lock for blood counts.  
0940 Dr. Houston down in lock.  
0956 McNutt has been riding bicycle for last 18 minutes. Lips more blue.  
1010 Allen up in lock for Buckley.  
1020 Allen and Buckley down in lock.  
1050 Subjects sleeping.  
1055 Relieved by Hall and McLean.  
1100 Hall and McLean assumed watch. Temperature 23 degrees. Ventilation 28 cubic feet per minute.  
1130 Wilkins rode bicycle for 2 minutes, then said, "To hell with it," and went to bed.  
1140 Powell up in lock with chow.  
1210 Powell down in lock with dishes.  
1300 Refrigeration system turned off.  
1301 Jones up in lock with cardiology equipment.  
1320 Damper opened, fan on for five seconds.  
1335 Generators started.  
1348 Damper opened, fan on.  
1358 McNutt in lock for electrocardiogram.  
1400 Horseplay between Wilkins and Hertel.  
1415 McNutt finished electrocardiogram. Morris in lock for electrocardiogram.  
1437 Generators off.  
1440 Morris finished electrocardiogram. Hertel started electrocardiogram.  
1500 Relieved by Pappas and DeNoyelle.  
1505 Two letters sent in to Morris "via air mail."  
1510 Refrigeration machine secured.  
1517 Wilkins ate raisins.  
1525 Jones down in lock.  
1536 LePenske up in lock with first bath water.  
1607 LePenske down in lock with bath water.  
1609 Lock climbed back up again; LePenske has ear trouble.



1610 Lock started down again at 2000 feet per minute.  
 1620 Hall up in lock with second bath water.  
 1645 Hall down in lock with bath water and dirty linen.  
 1700 McLean up in lock with chow.  
 1725 Lock down with McLean and mess gear.  
 1740 Bishop up in lock with bath water.  
 1800 Large vacuum pump checked. OK.  
 1815 Bishop down in lock with bath water.  
 1817 Started ascent to 19,000 feet.  
 1845 Note: all subjects had two iron pills today.  
 1858 McNutt seems pale and irritable.  
 1900 Pappas up in lock with beer and movies.  
 1926 Chamber fuse blown, lights and communications out. Emergency lights on. Subjects notified and are OK.  
 1945 Fuses replaced and movies continued.  
 2000 Chamber leveled off at new altitude: 19,000 feet.  
 2050 Movies completed. Hertel complains of chapped lips and feeling chilly.  
 2105 Pappas down in lock with movie machine.  
 2136 Lights out in chamber, all subjects in bed.  
 2300 Driver wakened to take home off-duty watch. Temperature 67 degrees. Ventilation 20 cubic feet per minute. Large vacuum pump checked. OK.  
 2300 Relieved of watch by Allen and Elms.  
 2301 McNutt restless and unable to sleep.  
 2400 Large vacuum pump checked. All subjects sleeping.

## 20 July

0100 Large vacuum pump checked. Subjects sleeping. Hertel restless, McNutt somewhat quieter. Temperature 72 degrees.  
 0110 Morris awake, rolled over, trying to go back to sleep.  
 0115 Hertel awake.  
 0145 McNutt up to head and back to bed.  
 0150 Hertel appears to be sleeping.  
 0210 Respiration check:  
     McNutt — 16 — Cheyne-Stokes type, irregular.  
     Morris — 17 — Full and regular.  
     Hertel — 17 — Very irregular, frequent pauses and occasional deep breaths.  
     Wilkins — 16 — Cheyne-Stokes.  
 0211 Pauling meter—61. Barometer—360 mm.  
 0230 Inboard motor bearing slightly warm.  
 0300 Large vacuum pump checked. Bearing still slightly warm, no change in last half hour.  
 0400 Large vacuum pump checked. No change.  
 0405 Morris awake, restless.  
 0440 McNutt up to head and back to bed.  
 0458 Morris appears to be laughing in his sleep. Hertel awake.  
 0500 Large vacuum pump checked—OK.  
 0530 Driver wakened.  
 0545 Dr. Houston and Vaughan wakened.  
 0600 Large vacuum pump checked—OK. Relieved of watch by Hall and McLean.



As soon as the blood and alveolar air samples were brought to the laboratory, Frank Consolazio (left) and George Selden started their precise studies.

## THE RESULTS

Operation Everest was primarily a study of fundamental physiology. Under the controlled conditions of the low pressure chamber it was possible to collect data which could not possibly be gathered under the rigorous conditions which prevail at great heights in the mountains. Even more important is the fact that the observers who studied the subjects were not affected by lack of oxygen themselves, and thus were better able to appreciate the small changes in the subjects which might escape the notice of a man suffering from lack of oxygen.

It will be months before all the data collected has been checked, sifted, and analyzed, and Operation Everest will probably be only the first of a series of similar studies. Of the almost numberless determinations which might have been done, we were forced to select the few considered most significant. The technique of placing an indwelling needle in the artery, beautifully developed by Dr. Riley, allowed us to draw arterial blood almost painlessly during work and rest periods. By collecting the exhaled air simultaneously the exact balance between carbon dioxide and oxygen in the lung and in the blood can be determined. Blood acidity,



blood sugar and lactic acid, the total amount of hemoglobin, and the percentage saturation of arterial blood can also be determined from specimens obtained by this method. The expired air indicates the metabolic state of the subject, while the volume of breathing was another determination made.

The step test of physical fitness, an experimental study which gives the pulse rate during rest, during a measured amount of work, and during recovery from work, was another study regularly made. From the results of these tests, Dr. Graybiel and Dr. Patterson will be able to draw fairly accurate conclusions as to the relative physical fitness of these men at various altitudes. The daily elctrocardiograms give a good picture of the working heart, and these studies in particular have never before been taken at such altitudes. The heart X-rays show the absence of any enlargement of the heart and reassured us that the men were not being injured.

Of course there were frequent blood counts for one of the best known adaptations to anoxia is an increase in the red blood cells and hemoglobin. The samples of alveolar, or lung air, which were the first specimens taken every morning, give a continuous picture of the gas pressure in the lungs at each altitude—data which, again, has never before been collected so completely. Thanks to Miss Haley there is a complete dietary history for each subject during the month, with his daily intake of calories, fats, proteins, vitamins, and iron; this study may be correlated with the men's conditions, with their weight loss, and with their success in acclimatization. The exciting possibility that some of the hemoglobin in the blood of our subjects did not carry oxygen as it should is one finding which, if true, may be of great clinical importance, but more work is required before this is certain.

Before the operation began it was expected that the subjects would make the adjustments necessary for life above 20,000 feet. This did not occur, and to this extent the study is disappointing, for it indicates that men confined to a space as small as the chamber do not, and cannot, adjust to altitude as rapidly or as completely as does the active mountaineer, even though the latter does not have the excellent food and rest available to the chamber subjects. Perhaps it is the fact that the mountaineer must do hard work which speeds his adaptation to altitude; of this we cannot be certain.

In the final days two men climbed to 29,000 feet without supplementary oxygen. They spent four hours above 25,000 feet, an altitude at which sea level man loses consciousness in less than ten minutes. True, the pair were not in any condition to work at 29,000 feet, but they were mentally alert, and able to remain at that altitude for twenty-one minutes before requesting that the descent be started. This is positive proof that our men were at least partially acclimatized, even though not as completely adjusted to altitude as the mountaineer.

The ascent to 50,000 feet gave us more concern, and in some ways was a more significant accomplishment. Due to the low total barometric pressure prevalent at altitudes above 40,000 feet, even a man breathing pure oxygen becomes rapidly anoxic at these altitudes. 44,000 feet is generally conceded to be the ceiling unless special equipment is used. This equipment, either a pressure mask, helmet, or completely pressurized suit, gives a man several more thousand feet, but only a handful of men have



remained for even a few minutes at 46,000 feet with pressure masks. Our partially acclimatized men remained for an hour at or above 45,000 feet, and even at 48,500 feet they were alert and capable of moderate work. This again is clear indication that their acclimatization had raised their altitude ceiling 6,000 to 8,000 feet above that of unacclimatized man. How this may be applied to aviation remains to be seen, but we can safely state that if acclimatization can be produced artificially, by drugs for example, this increase in absolute ceiling may be a major contribution to aviation medicine.

The ascents to 29,000 and to 50,000 feet were not mere stunts. They furnished an accurate measure of the improvement in altitude tolerance acquired by acclimatization of this degree. Together with the mass of detailed information obtained at lower altitudes, these two peak ascents thoroughly justify the months of thought and work which so many people gave to Operation Everest—the product of teamwork.

## THE CREW

Lieutenant Commander Richard L. Riley, (MC) USNR, was in charge of laboratory work for Operation Everest. Dr. Riley received his B. S. from Harvard College in 1933, and his M.D. from the Harvard Medical School in 1937. He interned in Providence, Rhode Island, and at St. Luke's Hospital, New York City, and later was Assistant Resident on the Tuberculosis Service at Bellevue Hospital in New York, where he worked in respiratory and circulatory physiology. In March, 1943, Dr. Riley worked on an Office of Scientific Research and Development project in traumatic shock. Following four months of general medical duty, Dr. Riley was assigned to the research section at the School of Aviation Medicine in Pensacola where he has worked in testing oxygen equipmeynt and in basic studies of respiratory physiology.

Lieutenant Walter H. Jarvis, Jr., (MC) USN, worked in the laboratory under the direction of Lieut. Comdr. Richard L. Riley during Operation Everest. Dr. Jarvis received his A.B. from Rice Institute in Houston, in 1938, and attended the University of Texas Medical School, graduating in 1942. Dr. Jarvis interned at the Philadelphia General Hospital, Philadelphia, Penna., and entered the Navy in January, 1944. He was first assigned to duty at the Naval Hospital, Corpus Christi, Texas, and later served with the Twelfth Construction Battalion at Camp Parks, California, and with Lion Eight at San Bruno, California. Dr. Jarvis was then assigned to Aviation Repair and Overhaul Unit Two and went overseas in October, 1944. After service in the Philippines he returned to the United States in February, 1946, and reported to the School of Aviation Medicine at Pensacola, for instruction. After graduation, Dr. Jarvis was assigned to research work in connection with Aviation Medicine.

Lieut. John L. Patterson, Jr., (MC) USNR, of Richmond, Va., worked with Captain Ashton Graybiel in the cardiology studies made on the four subjects taking part in the project. He received his A.B. degree from Princeton with the class of 1935, and then attended the Medical College of Virginia in Richmond, graduating in 1939. Dr. Patterson interned at Johns Hopkins Hospital in Baltimore, the Medical College of Virginia, and at the University of Virginia Hospital. After joining the Navy in 1944, he served at the National Naval Medical Center, Bethesda, Md., before he was assigned to the School of Aviation Medicine in Pensacola. Dr. Patterson's major work has been on the cardiovascular problems and the development of a set of physical fitness tests. During the project he took daily electrocardiograms of each of the subjects, and did studies on their heart action during rest, work, and recovery periods.

Lieut. (jg) Richard B. Morrison, USNR, of Lowell, Mass., prepared various pieces of special equipment used in the tests performed on the four volunteers. A graduate of Massachusetts Institute of Technology with a degree in aeronautical engineering, Lt. Morrison entered the Navy in Oc-

tober, 1943. After instruction at the Pratt and Whitney Engine School in Hartford, Conn., he was assigned to the Naval Auxiliary Air Station, Ellyson Field, Pensacola, as an instructor in aerodynamics and engines. Later he taught in the Intermediate Instructors' School, and was also assigned duty as Assistant Engineering Training Officer for the Naval Air Training Bases before being assigned as a Research Assistant in the School of Aviation Medicine in March, 1946.

Mr. Frank Consolazio, chief technician at the Harvard Fatigue Laboratory, Boston, Mass., was sent to Pensacola on loan from Harvard University to assist in the laboratory work of Operation Everest. Familiar with high altitude work, Mr. Consolazio took part in the Mt. Evans (Colorado) high altitude study in 1940, and the Wright Field (Ohio) Aero-Medical Research Laboratory high altitude studies in 1941. Mr. Consolazio has been a member of the staff of the Harvard Fatigue Laboratory since 1929, and as their chief technician for the past ten years has taken part in practically every expedition sent out from the laboratory, including the dry heat studies at Boulder Dam, Nevada, in 1932 and 1937, the Mississippi studies on humid heat in 1939, and ration trials at Prince Albert, Saskatchewan, Canada, in 1944, and most recently, "Operation Musk-Ox," Canadian Army Arctic study. His war work for the Office of Scientific Research and Development, under the direction of Professor William H. Forbes included studies in nutrition, ration trials, and acclimatization to cold as well as the high altitude studies.

Mr. George Selden of Andover, Mass., came with Mr. Consolazio from the Harvard Fatigue Laboratory to assist in the laboratory work for Operation Everest. A graduate of Phillips Andover Academy in 1944, Mr. Selden had just started his studies at Harvard when he was drafted into the Army. Following basic training at Fort Belvoir, Va., with the Combat Engineers, Mr. Selden taught demolition at Fort Belvoir until he was assigned to the 704th Military Police Company. Shortly thereafter he was transferred to the Harvard Fatigue Laboratory to assist in cold climate studies, both as subject for the experiments and as a technician. He was discharged from the Army just prior to coming to Pensacola. Mr. Selden's work on Operation Everest was concerned with air analyses, respiratory and metabolism tests.

Dr. John W. Remington, Assistant Professor of Physiology at the University of Georgia Medical School, Augusta, Ga., brought to Pensacola a method for measuring cardiac output. A graduate of the College of Charleston, Charleston, S. C., Dr. Remington received his M. S. degree from New York University in 1937, and his Ph.D. at the same university in 1939, for work in physiology. Prior to assuming his present post at the University of Georgia, Dr. Remington was for four years a research associate at Princeton University where he worked on glands of internal secretion, shock, hypertension, and cardiac output, and during the war participated in an Office of Scientific Research and Development project which studied shock.



Lieut. Commander Margaret L. Haley, Nurse Corps, USN, was assigned to the School of Aviation Medicine at Pensacola on temporary additional duty from her assignment as Chief Nurse at the Naval Hospital, Key West, Fla., to take over the dietary studies on the four subjects. Miss Haley trained at St. Catherine's Hospital, Brooklyn, N. Y., where she worked as a supervisor prior to entering the Navy in January, 1935. In August of 1941, she was assigned to the hospital ship USS Solace for a 16-month cruise, and was at Pearl Harbor when the war broke out. Her ship left for the South Pacific early in 1942, and evacuated casualties from Guadalcanal. Returning to the United States in March, 1943, Miss Haley was assigned to the Naval Base at Treasure Island, California, and the Naval Hospital at Sun Valley, Idaho, as chief nurse. Following this she was assigned to the Naval Hospital at St. Alban's, N. Y. Miss Haley wears the Secretary of the Navy Unit Citation for service at Pearl Harbor. Upon arriving at Pensacola Miss Haley set up a kitchen in one of the laboratories of the School of Aviation Medicine, and there prepared all the meals which the four subjects ate during their stay in the low pressure chamber. She also recorded all the dietary data collected during the month of the project.

Assisting Miss Haley in the preparation of meals for the four subjects was R. Maurice Bowman, Seaman, first class, USNR, of Jacksonville, Fla. Bowman entered the Navy in April, 1945, and after recruit training at Great Lakes, Illinois, was assigned to duty at the Naval Air Station, Jacksonville, Fla., for ten months prior to reporting to Pensacola. A reporter for the St. Petersburg Times, St. Petersburg, Fla., before entering the Navy, Bowman plans to enter Southern College at Lakeland, Fla., to prepare for the ministry.

Ronald D. Popham, Seaman, first class, USNR, of Williams Town, Kentucky, assisted Miss Haley in the preparation of meals for the subjects. Popham entered the Navy in March, 1945, and after recruit training at Great Lakes, Illinois, was stationed at the Naval Air Station, Jacksonville, Florida, for eleven months prior to being assigned to duty at Pensacola. He was separated from the naval service at the conclusion of Operation Everest.

Lieutenant Carl E. Hoffman, H(S), USNR, of Appleton, Wisconsin, an instructor in the Altitude Training Unit at the School of Aviation Medicine, assisted in the physiology work during the early stages of Operation Everest. A graduate of Lawrence College in Appleton, Wisconsin, he received his M.A. and Ph.D. degrees from the University of Michigan. Prior to entering the service in August, 1944, Lieut. Hoffman was Associate Professor of Zoology at the University of Arkansas, Fayetteville, Ark., and returned to this position after his discharge from the Navy.

Jacob P. Wagenaar, Seaman, first class, USNR, of Chicago, Illinois, assisted Miss Haley in the galley and drove the truck during the project. A graduate of Fenger High School, Wagenaar entered the Navy in June, 1945, and after recruit training at Great Lakes, Illinois, was stationed at the Naval Air Station, Jacksonville, Fla., for nine months prior to assignment to duty at Pensacola. He was discharged from the Navy shortly before the conclusion of Operation Everest.

Marvel J. Jones, Yeoman, second class, USNR, the only WAVE working on Operation Everest, attended Iowa State Teachers' College (Cedar Fall, Iowa), graduating **cum laude** in 1944 with a degree in chemistry and biology. While in college she was a member of the Civil Air Patrol during her senior year. Following graduation she worked as a research chemist for a year with the Philipps Petroleum Company, enlisting in the WAVES in May, 1945. After basic training at Hunter College, Miss Jones was assigned to Pensacola as a chemist and assisted in studies at the acceleration unit. In January, 1946, she was assigned duty in the School of Aviation Medicine as a research assistant. During Operation Everest she assisted Captain Grabiell and Dr. Patterson in the cardiology studies made on the subjects.

Burton E. Vaughan, Pharmacist's Mate, third class, USNR, of Berkeley, California, maintained certain of the highly specialized recording devices used during Operation Everest. A graduate of University High school, Vaughan attended the University of California for two years prior to entering the naval service in June, 1944. Following recruit training and Hospital Corps training at Farragut, Idaho, Vaughan attended Low Pressure Chamber Technician's School at Alameda, Calif., and has done this type of work during most of his naval service. Vaughan requested retention on active duty in order to work on Operation Everest. At the conclusion of the project, Vaughan was separated from the naval service and planned to return to medical studies at the University of California.

George Edward Bentley, Jr., Machinist Mate, second class, of Waterbury, Conn., assisted in the engineering work for Operation Everest, maintaining pumping and electrical equipment necessary to the project. A student at Waterbury High School when he entered the Navy in July, 1944, Bentley underwent recruit training at Sampson, N. Y., and was assigned to the Naval Air Station, Pensacola, Florida, for a short period before being sent to the Compressed Gas School at Camp Perry, Virginia. Following training, he returned to duty at Pensacola, and worked in research in connection with oxygen studies. He was discharged from the Navy during the project.

Leo Arthur Bergeron, Fireman, first class, USN, of New Bedford, Mass., was one of the engineers assigned to the study. A former student at St. Anthony's High School in New Bedford, Bergeron entered the Navy in October, 1944, and after recruit training at Sampson, N. Y., was assigned to the Naval Auxiliary Air Station, Bronson Field, Pensacola. He was later transferred to the main Naval Air Station, where after a short period of duty as a member of the seaman guard, he was assigned to the low pressure chamber at the School of Aviation Medicine. His duties are concerned with liquid oxygen equipment and refrigeration units.

Chief Pharmacist's Mate Emanuel N. Buckley, USN, of San Diego, Calif., did the blood counts on the four volunteers. A graduate of San Diego High School in 1940, Buckley entered the Navy in January, 1941, and underwent recruit training and Hospital Corps School training at San Diego. Assigned to the USS Rixey, he left the United States for overseas duty in February, 1943, and served at Samoa, New Caledonia, New Hebrides, and other South Pacific areas. During twenty-seven months in the Pacific Buckley participated in the invasions of Guam, Leyte, Lin-



gayen, Kerama Retto, and returned to the United States in May, 1945. Following rehabilitation leave he was assigned to duty at the Per. Sep. Center, Naval Air Station, Pensacola, and early in 1946, was placed in charge of the laboratory at the main Dispensary.

Bobby H. Bunch, Hospital Apprentice, first class, USNR, of Rockport, Missouri, took regular X-rays of each of the four volunteers to furnish measurements of heart size. A graduate of Rockport High School, Bunch entered the Navy in April, 1945, and after recruit training at Great Lakes, Illinois, attended Hospital Corps School at San Diego, California. He was then assigned to duty at the Shoemaker (California) Naval Hospital until January, 1946, when he was transferred to the Personnel Separation Center in St. Louis, Mo., for a short period. Since March, 1946, he has been assigned to the Dispensary at the Naval Air Station, Pensacola, as an X-ray technician. Following discharge from the naval service he plans to study electrical engineering in Chicago.

The fourteen members of the operating crew, divided into seven groups of two men each, rotated the watches during the month. The entire group was chosen from a class of low pressure chamber technicians under training at the time the project began.

Robert C. Allen, Chief Pharmacist's Mate, USN, of Owasso, Oklahoma, entered the Navy in December, 1939, and after recruit training and Hospital Corps School at San Diego, California, was attached to the San Diego Naval Hospital until the end of 1940. He was assigned to the Marines and sent overseas in June, 1942, with the 22nd Marines to British Samoa. Returning to the States in April of 1944, Allen was sent to the Great Lakes Naval Hospital, and in February of 1945, was transferred from there to the Portsmouth, Virginia, Independent Duty School. Graduating in May, 1945, Chief Allen was assigned to Corona, California, until May 1946, when he was sent to Pensacola for instruction.

Edice Emil Anderson, Chief Pharmacist's Mate, USN, of Maquoketa, Iowa, enlisted in the Navy in January, 1941. Following recruit training at Great Lakes, Illinois, Hospital Corps School at Portsmouth, Virginia, and training at the Neuro-psychiatry School in Washington, D. C., he was assigned to duty at the Naval Hospital, Chelsea, Massachusetts. Anderson served overseas in Europe and the Pacific aboard the USS PC 455 and the USS YMS 298 for three years, and upon his return to the United States was again assigned to duty at the Naval Hospital, Chelsea, Mass., prior to being sent to the School of Aviation Medicine, Pensacola, Fla., in May, 1946.

Joseph Bishop, Pharmacist's Mate first class, USN, of San Jose, California, entered the Navy in September, 1941, shortly after graduation from San Jose High School. Following recruit and Hospital Corps training at San Diego, Calif., he was assigned to duty at Mare Island, California, and was sent overseas to American Samoa in July, 1943. He served aboard small craft until his return to the United States in June, 1945. He has since had duty at Jacksonville, Florida, prior to being assigned to Pensacola for training in Aviation Medicine.



Raymond Wilfred DeNoyelle, Pharmacist's Mate, first class, USN, of Woonsocket, Rhode Island, entered the Navy in February, 1942. Following completion of recruit training at Newport, R. I., he attended Hospital Corps School at Brooklyn, N. Y., and was then transferred to the U. S. Naval Hospital at Quantico, Va., and later to Cub Three at New Orleans, and Moffet Field, Calif., for advanced training. His next assignment was at San Francisco County Hospital as an Operating Room Technician. From there he was ordered to Oakland, Calif., for duty aboard the USS LaSalle and service in the South Pacific. DeNoyelle was assigned to Quonset Point, Rhode Island, in November, 1944, and later attended Independent Duty School.

Charles Ray Elms, Pharmacist's Mate, second class, USN, of Bell Garden, California, entered the Navy in September, 1942, and after recruit and Hospital Corps training at San Diego, California, was assigned to duty at Mare Island, California, until he was sent overseas with the Fleet Marine Force in May, 1943. While overseas, Elms served with the First Marine Paratroop Regiment, making six jumps while in New Caledonia. During his service with the regiment, he participated in the Valla la Valla, and Bougainville campaigns, and wears the Purple Heart for wounds received there.

Benny Christopher Freeman, Pharmacist's Mate first class, USN, of Geleta, Calif., received recruit training at San Diego, California, and attended Hospital Corps School at the Naval Hospital, San Diego, before he was transferred to the Marine Base in San Diego and then to the Fleet Marine Force at Camp Elliott for duty with a medical company in the Second Marine Division. He left the United States with Company D, Third Medical Battalion, Third Marine Division, in February 1943, and served overseas for 20 months.

Harold Leon Hall, Pharmacist's Mate, first class, USN, of Sallisaw, Oklahoma, entered the Navy in September, 1941. Prior to entering the service, Hall, a graduate of Sallisaw High School, attended Oklahoma Agriculture & Mining College for a year and a half. After recruit training and Hospital Corps School at San Diego, California, he had duty at Bremerton, Washington, for a short period before being sent to the Naval Base at Sitka, Alaska. Hall served at various bases in Alaska until March, 1943, when he was assigned to the USS Herald. He participated in the Kiska, Attu, and Ogattu operations until his ship moved to the South Pacific, where she took part in the Marshalls invasion and later the Mariannas attack. In August, 1944, Hall was assigned to the Fleet Marine Forces for the invasion of the Palau Islands. Later he was sent to Leyte, and finally back to the United States in February, 1945, after 33 months overseas. Since his return to this country Hall has served at the Naval Hospital, San Diego, Calif., and at Pensacola.

Denis W. LePenske, Pharmacist's Mate, second class, USN, of Louisville, Colorado, attended Louisville High School before he entered the Navy early in 1942. After recruit and Hospital Corps training at San Diego, California, he went to the National Naval Medical Center at Bethesda, Md., and then to Camp Elliott, Calif., for training with the Fleet Marine Forces. He was sent overseas to New Caledonia to the Marine Casual Camp as a replacement in the Second Marine Division. He completed 23 months of overseas duty during which time he flew patrol and air-sea rescue with a Black Cat Dumbo Squadron.

John R. McLean, Pharmacist's Mate, second class, USN, of Ponce de Leon, Florida, attended Walton High School prior to joining the Navy in July, 1942. He was transferred to duty with the Fleet Marine Force at Camp Elliot after recruit training and Hospital Corps School at San Diego, Calif., and soon after was assigned to duty with the First Corps Motor Transport Battalion, Third Marine Division, and sailed for New Caledonia in March, 1943. After six months of training, McLean took part in the invasions of the Russell Islands and Guam. After nineteen months of sea duty, he returned to the States in September, 1944, and was assigned to duty at the U. S. Naval Receiving Hospital, San Francisco, where he assisted with the evacuation of patients to various hospitals throughout the country.

John Leonard Mele, Pharmacist's Mate, second class, USN, of Brooklyn, N. Y., entered the Navy in March, 1942, and after recruit training at Newport, R. I., attended Hospital Corps School at the Brooklyn Naval Hospital. In August, 1942, Mele was sent overseas with Cub 13, and served in New Caledonia for six months prior to transfer to Mobile Hospital Five. Later he served as an ambulance driver at Tulagi, and had several other assignments before returning to this country in July, 1944. He has since served at St. Alban's Naval Hospital, and at the Independent Duty School in Portsmouth, Va.

Lyle E. Morgan, Chief Pharmacist's Mate, USN, of Leon, Iowa, a graduate of Leon High School, entered the Navy in March, 1938. Following recruit training at Great Lakes, Ill., he served aboard the USS Maryland for a year before being assigned to the Hospital Corps School at San Diego, Calif., for instruction. He also attended the Laboratory School and the Field Medical School at San Diego, and then was assigned to the Second Marine Division and later to the Second Raider Battalion. Morgan served overseas at Samoa, Makin, Guadalcanal, Tarawa, and New Zealand, and wears the Presidential Unit Citation with two stars.

Jimmy P. Pappas, Pharmacist's Mate, first class, USN, of Lincoln, Nebraska, joined the Navy in July, 1942, after graduation from Jackson High School. Following recruit training and Hospital Corps School at Great Lakes, Illinois, he was sent to the Naval Hospital in Philadelphia, Pa., and shortly afterwards was assigned to the USS Santa Fe. Pappas served at sea until October, 1944, when he was assigned to the Independent Duty School at Portsmouth, Va. After duty at the Naval Hospital in Oakland, Calif., he was sent to the School of Aviation Medicine at Pensacola. During his overseas duty, Pappas took part in the attacks on Attu, Kiska, Tarawa, Makin, Wake, Bougainville, Guam, Truk, Ponape, the Marshall Islands, Yap, Saipan, Hollandia, and the Admiralty Islands.

Oscar Herman Patrick, Pharmacist's Mate, first class, USN, of Atlanta, Georgia, attended Coleman High School in Coleman, Ga., and the Gordon Military Academy in Barnesville, Ga., before he entered the Navy in September, 1941. After recruit training at the Norfolk Naval Training Base and Hospital Corps School at Portsmouth, Va., he had duty at the Naval Hospitals in Portsmouth and in Jacksonville, Fla., until May, 1942, when he was sent overseas. Patrick served in New Zealand with Mobile Hospital



Six until his return to the United States in June, 1944. He was then assigned to the Naval Hospital at Philadelphia, and had various other duties before coming to the School of Aviation Medicine in Pensacola in May, 1946.

James Edwin Powell, Pharmacist's Mate, first class, USN, of Decatur, Alabama, joined the Navy in 1939. Following recruit training at Norfolk, Virginia, and Hospital Corps School at Portsmouth, Va., he had duty at the Naval Hospital in Pensacola, the Naval Air Stations at Jacksonville, Fla., and at Memphis, Tenn., and the Naval Aviation Pre-flight School in Athens, Ga. He served aboard the USS LCI (L) 19, and was at Guadalcanal with the First Marine Division. Upon return to the United States he was assigned to the Naval Hospital at Portsmouth, Va., before being sent to the School of Aviation Medicine in Pensacola.

David G. Stahl, Seaman, first class, USNR, of Manchester, New Hampshire, was assigned to Operation Everest from the Naval Air Training Bases Office of Public Information. A graduate of Manchester Central High School in 1943, Stahl attended Dartmouth College in Hanover, N. H., completing his junior year before he entered the naval service in February, 1945. Following recruit training at Great Lakes, Illinois, Stahl was stationed at Naval Training Schools in Chicago, Ill., and Dearborn, Mich. He was assigned to duty at Pensacola in April, 1946, as managing editor of the Gosport, Naval Air Training Bases weekly newspaper. Stahl was discharged from the service during Operation Everest, but remained in Pensacola to serve as a member of the operating crew and Public Information Office representative. He plans to return to his college studies.

Mr. William E. Cater, of Pensacola, leading refrigeration mechanic in the Public Works Department, Naval Air Station, took a large part in the work of preparation for and carrying out of Operation Everest. A member of the Mechanical trades for over twenty years, Mr. Cater served his apprenticeship with the railroad shops in Pensacola, and from 1926 to 1936 was with the Gulf Power Company repairing refrigeration, air conditioning, and electrical equipment. He then started work at the Naval Air Station, and soon become chief mechanic of his department, in charge of refrigeration for the Naval Air Training Bases and the Naval Hospital. In connection with Operation Everest, Mr. Cater supervised the installation of an auxiliary vacuum pump and emergency electrical equipment. He overhauled the refrigeration system and installed a drying unit to control the humidity in the low pressure chamber. Under his direction, several pieces of highly specialized and complicated equipment for the project were constructed, including a pumping device used for the blood studies. Mr. Cater was on twenty-hour call during the project.



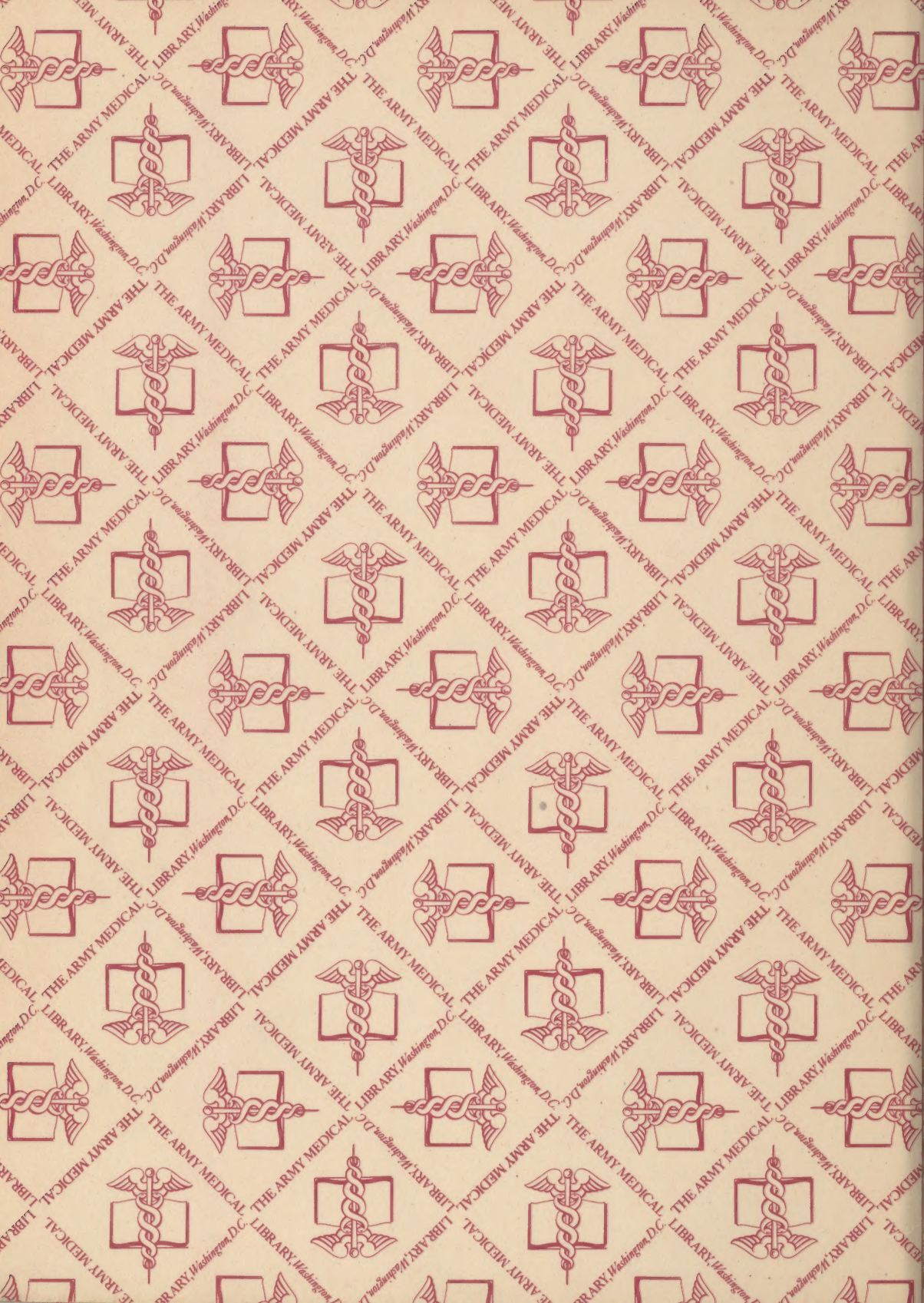
## THE STAFF OF OPERATION EVEREST

Captain Louis Iverson, (MC) USN	Senior Medical Officer
Captain Kirk Smith, (MC) USN	Executive Medical Officer
Captain Ashton Graybiel, (MC) USN	Director of Research
Lt. Cdr. C. S. Houston, (MC) USNR	OinC Project X-720
Lt. Cdr. R. L. Riley, (MC) USNR	In Charge of Laboratory
Lt. Walter Jarvis, (MC) USN	Assistant
Mr. Frank Consolazio	Assistant
Mr. George Selden	Assistant
Lt. John Patterson, (MC) USNR	Cardiologist
Dr. John Remington	Assistant
Lt. Cdr. Margaret Haley, (NC) USN	Dietician
Lt. Carl Hoffman, H(S) USNR	Respiratory Tests
Lt. John Self	NATB Liaison
Ch. Pharm. F. A. Frerichs	Dispensary Supplies
Lt. (jg) R. B. Morrison	Electrical Recording
Ashenfelter, R. H., AMM3c	Electrician
Axler, N., HA1c	X-ray
Bentley, G., MM2c	Engineer
Bergeron, L., F1c	Engineer
Bowman, R. M., S2c	Mess Boy
Buckley, E. N., CPhM	Clinical Laboratory
Bunch, R., HA1c	X-ray
Mr. Ed Cater	Public Works, Maint.
Jones, M., Y2c (W)	Assistant Cardiologist
Mr. W. J. Kelly, Jr.	Refrigeration Mechanic
Pittman, C. O., CAP	Electrical Recording
Popham, S2c	Mess Boy
Mr. John Ronnlof	Electrical Recording
Stahl, D. G.	Literary Work
Usher, J., PhoM2c	Photographer
Vaughan, Burton E., PhM3c	Instrument Technician
Wagenaar, J. P., S2c	Mess Boy
Allen, R. C., CPhM	Operating Crew
Anderson, E. E., CPhM	Operating Crew
Bishop, J. W., PhM1c	Operating Crew
DeNoyelle, R. W., PhM1c	Operating Crew
Elms, C. R., PhM2c	Operating Crew
Freeman, B. C., PhM1c	Operating Crew
Hall, H. L., PhM1c	Operating Crew
LePenske, D. W., PhM2c	Operating Crew
McLean, J. R., PhM2c	Operating Crew
Mele, J. L., PhM2c	Operating Crew
Pappas, J. P., PhM1c	Operating Crew
Patrick, O. H., PhM1c	Operating Crew
Powell, J. E., PhM1c	Operating Crew
Morgan, L. E., CPhM	Operating Crew

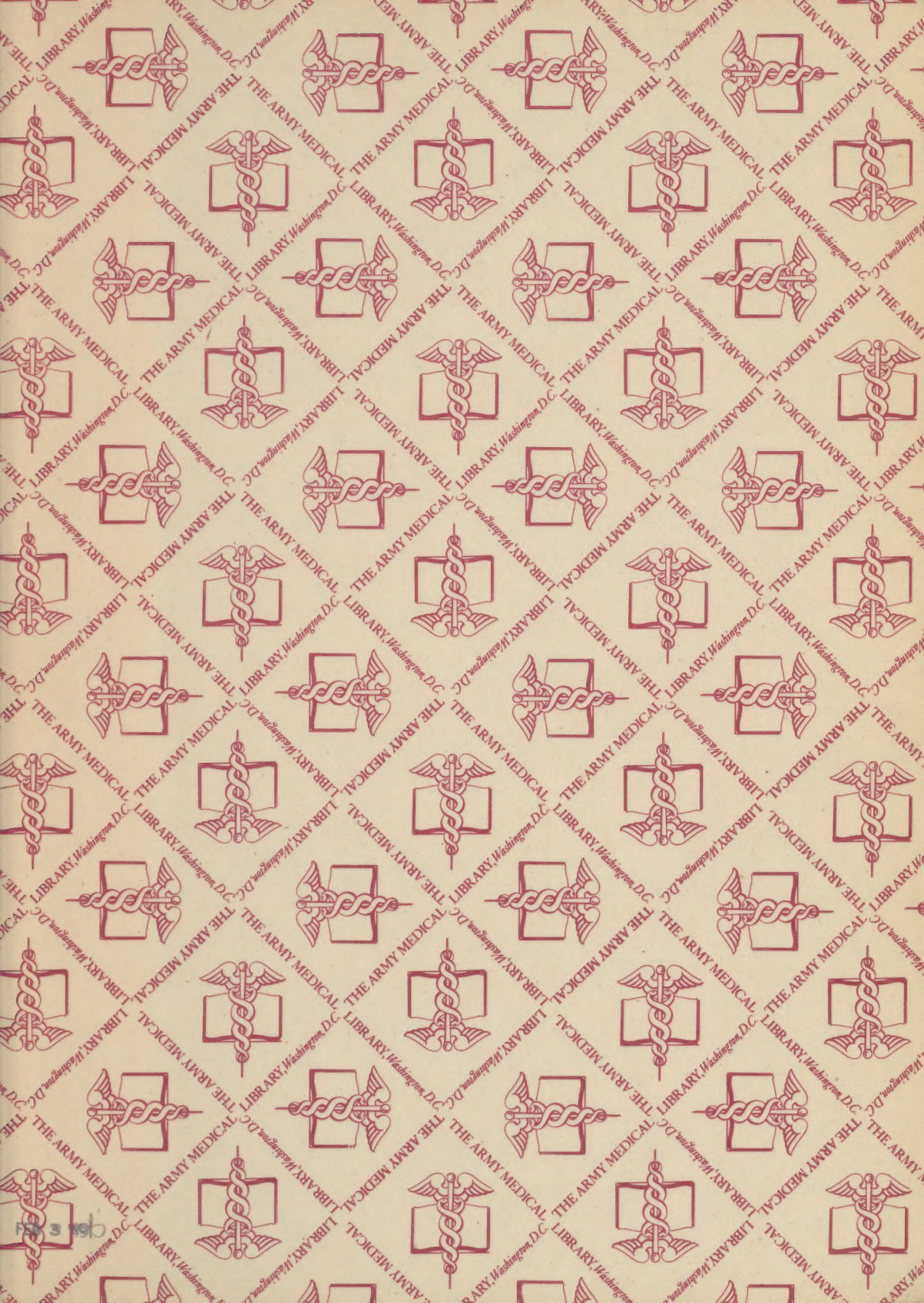
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